Design for Six Sigma (DFSS)

- DFSS is a systematic methodology to design new products or processes so that quality is built into every phase of product design. It is also used for improving existing products through redesign.
- The roots of DFSS are in systems engineering. It combines systems engineering methodology with statistical methods to achieve 'built-in quality' objectives.
- DFSS optimizes the critical to quality (CTQ) characteristics to achieve the best system performance. (CTQs are the selected few measurable quality characteristics that are key to a specific product, process, or service that must be controlled to meet or exceed customer expectation).
- DFSS uses Robust Design, Design of Experiment (DOE), Design for Manufacturability, Simulation and several other tools to optimize product design.
- DFSS balances the cost and quality.
- DFSS reduces the development cycle time in the long run.
- In DFSS, both engineering methods and statistics are used to optimize the design requirements.
- Like Six Sigma, the DFSS also uses a collection of tools. These tools must be understood in context to the engineering design for achieving DFSS objectives.

Design for Six Sigma Methodology

- The DFSS methodology has been identified by a five-step process: **DMADV** that stands for Define, Measure, Analyze, Design, and Verify. These are explained briefly.
- **Define**: determine the project need, identify the project goals and objectives, determine customers' needs and requirements, and include the voice of customers (VOC)
- **Measure:** determine the characteristics critical to quality, prioritize customer needs and requirements, and assess customers' needs and CTQ metrics
- **Analyze:** evaluate the process options to meet customers need and CTQs
- **Design:** design product and process to meet the customer requirements, include customer requirements in the development process
- **Verify:** check the design to ensure that the customers' requirements are met

The DFSS is also identified by IDOV process that stands for Identify, Design, Optimize, and Validate.

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IDOV process

- **Identify**: Identify customer requirements, and address the voice of customer (VOC) issues. Prioritize customer requirements, use house of quality to identify and define CTQs.
- **Design**: Identify product design parameters and characteristics; build a database about the product and related process, and 'design in' key customer requirements.
- **Optimize**: Optimize the design to achieve a balance of quality, cost, and time to market. Create 'robust' design that will minimize the impact of variation in the production process.
- **Validate:** Demonstrate using data that the product and process is capable, the process capability meets appropriate sigma level, satisfies the CTQs, and meets the customer's requirements (VOC) and expectations.

Design for Six Sigma Tool

Tools available to aid in the product design and development process

- Quality Function Deployment and House of Quality
- Concurrent Engineering
- CAD/CAM
- Robust Design
- Detailed Design and Analysis (Tolerance Design, Design for Manufacturability, Standardization and Simplification)
- Failure Mode and Effects Analysis (FMEA)
- Reliability Testing

QFD (Quality Function Deployment): An Important Tool for DFSS

Quality Function Deployment (QFD) is an approach used to meet the customers' requirements in the product design and development. It helps to integrate the voice of customers and critical quality characteristics in the design of the products so that the products meet or exceed customer expectations.

QFD helps eliminate the traditional and wasteful design/redesign efforts by identifying and incorporating customer requirements at the earliest stage of design. Other benefits of QFD include.

- closer interaction between marketing, design, manufacturing, purchasing, and suppliers
- reduced product development time,
- faster market entry, and
- customer focus..

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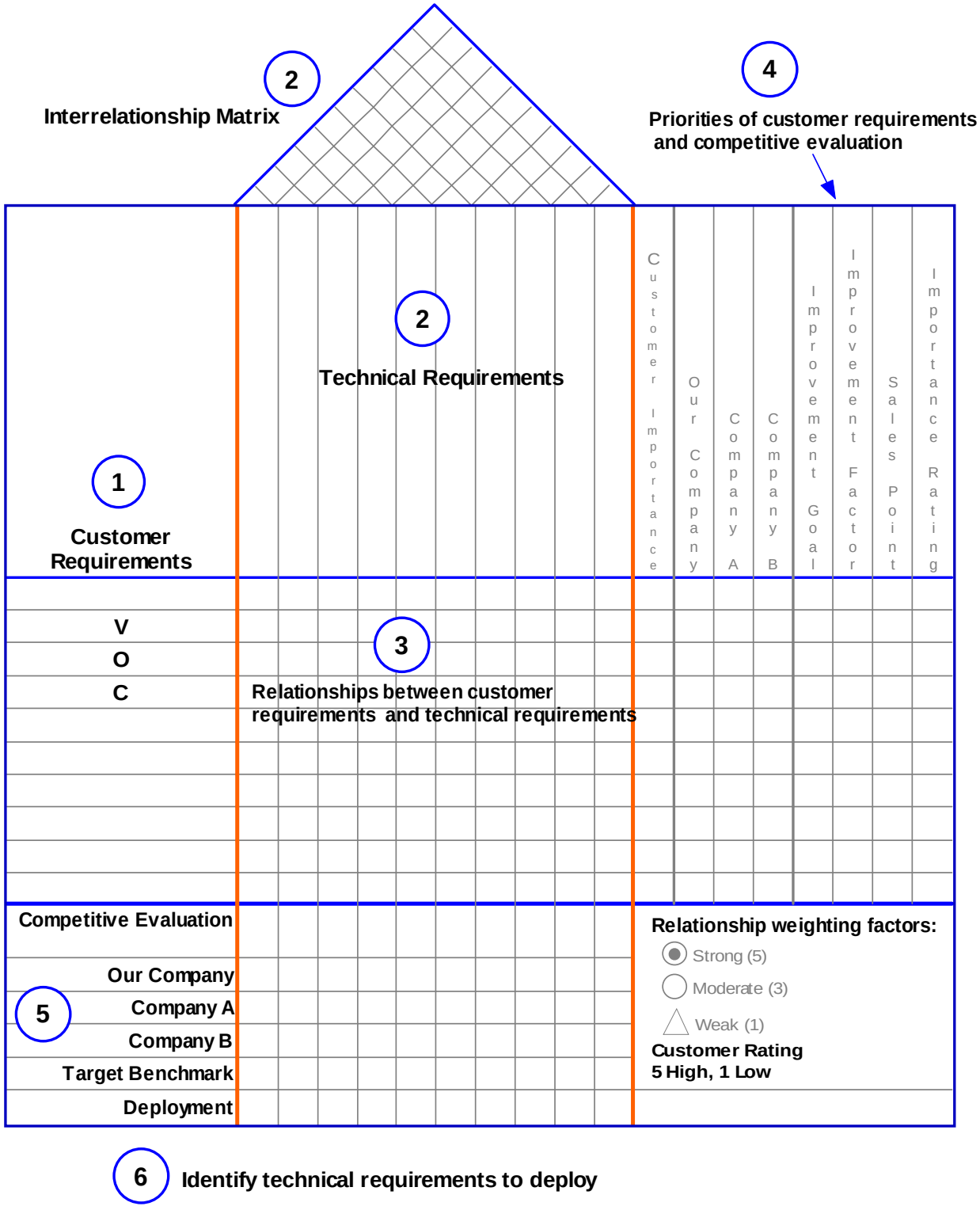
QFD (Quality Function Deployment) Process



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Difference between Six Sigma and Design for Six Sigma

Six Sigma	Design For Six Sigma (DFSS)
Six Sigma aims to improve the existing process by reducing or minimizing the causes of variation.	Design for Six Sigma (DFSS) efforts are focused on designing products and processes capable of reaching Six Sigma quality
Six Sigma methodology works within the framework of the existing process. It finds and fixes problems in the existing process.	DFSS aims at improving quality at the design phase of products and processes. DFSS is also used to redesign current products and processes.
Six Sigma is based on a strategic improvement methodology known as **DMAIC,** which stands for **D**efine, **M**easure, **A**nalyze, **I**mprove, and **C**ontrol.	DFSS is based on **DMADV** methodology that utilizes the following phases: **D**efine, **M**easure, **A**nalyze, **D**esign, and **V**erify DFSS is also identified by **IDOV** process that has the following phases **I**dentify, **D**esign, **O**ptimize, and **V**alidate
Six Sigma improvement projects are based on the assumption that the design of current product, process, or service is correct and most economical, meets the needs and requirements of customers, and the design satisfies the functional requirements of the customer and market [Nave,2002].	**DFSS** intends to create design that are : Resource-efficient, Capable of reaching very high yields, 'robust' to process variability, and highly linked to customer demands
Six Sigma teams aim at achieving constant incremental improvements by reducing or minimizing causes of variation in the current process.	DFSS is design/redesign efforts. Its goal is to build quality early in the design stage or redesign existing product to improve current sigma level.
Six Sigma is considered *reactive* because it involves detecting and resolving problems.	DFSS is considered *proactive*; it involves preventing problems through prediction.
Six Sigma is based on manufacturing or transactional processes	DFSS focuses on product/process design, R&D, and marketing.
The benefits or cost savings from Six Sigma can be quantified rather quickly	DFSS benefits are long term and are difficult to quantify. It takes six to 12 months to realize the impact of DFSS effort.
Six Sigma optimizes individual CTQs	DFSS optimizes CTQs for optimal system level performance.
Six Sigma has component level view of product. In Six Sigma, the product performance is assessed by 'build and test'	DFSS has system level view of product DFSS uses modeling and simulation with optimal prototyping strategy to assess the product performance

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LEAN, SIX SIGMA, OR DESIGN FOR SIX SIGMA (DFSS)?

- More and more companies are realizing that it is possible to achieve dramatic improvements in cost, quality, and time by using the Lean Six Sigma and Design for Six Sigma (DFSS).

- Several companies including Toyota, General Electric, Motorola have accomplished impressive results using one or more of the techniques mentioned.

- However, using only one method — Lean, Six Sigma, or Design for Six Sigma — has limitations.

- Six Sigma eliminates defects during the production phase, but does not address the importance of quality effort in the research and design phase of a product. Also, Six Sigma does not address the question of how to optimize the process flow, and the Lean principles do not address the use of advanced statistical tools required to reduce variation, defects and achieve the process capabilities needed to be truly 'lean'.

- Unlike Six Sigma, the Design for Six Sigma (DFSS) is not standardized and is not deployed well in industry.

- The goal of DFSS is to address and incorporate quality issues early in the design/redesign process using robust design methodologies.

- Companies who have successfully employed the Six Sigma program have found that once they achieve 5-sigma quality levels (233 defects per million opportunities), they must design or redesign their products, processes and services by means of DFSS to surpass this quality level [11].

- The cost to correct the potential design problems to reduce the defect level to achieve higher quality level (above 4-sigma) is usually greater than the projected cost savings of the further improvement effort [24].

- Quality must be built in the design phase, and the quality issues must be addressed early in the design process.

- To achieve Six Sigma quality level, the companies must determine where the Lean, Six Sigma, and Design for Six Sigma activities occur in the life cycle of the product.

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- Companies must determine when to apply the Design for Six Sigma or DFSS approach.

- There is a need for an integrated approach to achieve the overall objectives. It is important for the companies to identify and initiate appropriate projects based on Six Sigma, Lean, or Design for Six Sigma depending on the objectives and priorities.

- Sometimes a combination of these methodologies (Lean, Six Sigma, and Design for Six Sigma) is needed as an integrated approach to achieve the overall objectives of improving quality, reducing defect and becoming a Six Sigma company, reducing cost, eliminating waste, providing speed and reliability of delivery, incorporating flexibility and innovation in products and services, and meeting or exceeding customer expectations.

- Selecting and initiating the right project – Lean, Six Sigma, or Design of Six Sigma (DFSS) is critical.

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